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### Title

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### Permalink

<https://escholarship.org/uc/item/5ff0z220>

### Journal

Journal of adolescent and young adult oncology, 9(3)

### ISSN

2156-5333

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### Publication Date

2020-06-01

### DOI

10.1089/jayao.2019.0116

Peer reviewed

# Emotional Processing Coping Methods and Biomarkers of Stress in Young Adult Testicular Cancer Survivors

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Coping through emotional processing (EP) with cancer-related circumstances can take several forms, including methods thought to be constructive (e.g., planning, meaning making) and unconstructive (e.g., rumination). These forms can have differential relationships with experiences of stress. Associations of coping through constructive and unconstructive EP in expressive writing with salivary stress biomarkers were examined among young adult testicular cancer survivors. Constructive processing was significantly associated with less overall daily cortisol output and smaller salivary alpha-amylase awakening response; unconstructive processing was also associated with lower daily cortisol output. These preliminary results from this exploratory study inform future research associating emotion-regulation coping and biological stress reactivity.

**Keywords:** emotional processing, testicular cancer, coping, young adult, cortisol, alpha amylase

## Introduction

A CANCER DIAGNOSIS during young adulthood can present myriad unexpected stressors and disruption across life domains.<sup>1</sup> Following treatment for testicular cancer, such stressors can persist well beyond the conclusion of treatment and include threatened masculinity, alternations in social relationships, problems with fertility, and persistent fear of cancer recurrence.<sup>2</sup> Over time, the chronicity of such stress perceptions can reflect perseverative cognition or repetitive stress-related thought cycles (e.g., worry, rumination) resulting in prolonged activation of physiological stress response systems, including the hypothalamic/pituitary/adrenal (HPA) axis (e.g., cortisol) and the sympathoadrenal medullary (SAM) system (e.g., alpha-amylase).<sup>3,4</sup>

Salivary cortisol, as a downstream marker of HPA activity, and salivary alpha-amylase (sAA), as a proxy measure of SAM activation, can be measured concomitantly<sup>4</sup> and together offer a comprehensive view of physiological stress, as differing diagnostic and treatment effects have been observed between these markers.<sup>5</sup> Both salivary cortisol and sAA follow a distinct diurnal rhythm: cortisol levels peak ~30 minutes after awakening and decrease throughout the day, whereas sAA has a pronounced decline after awakening followed by an increase across the day.<sup>4</sup> Dysregulation in these rhythms are observed in the presence of chronic stressors and are associated with psychological distress, early mortality, and overall physical symptom burden in cancer survivors.<sup>6–9</sup> Despite the need to understand psychological adjustment to cancer in young adults, little atten-

tion has been given to biological stress processes and cancer-related coping in this survivorship group.

Understanding cognitive coping processes, such as coping through emotional processing (EP), which serve to resolve, maintain, or amplify the stress response is paramount. When utilized as a process of coping, as purported by stress and coping theory, EP works in service of managing stressors (i.e., demands related to cancer) perceived as stressful and can be viewed as a transaction between the individual and the environment.<sup>10</sup> Stressors related to cancer can be emotion laden. Processing cancer-related emotions enables “emotional disturbances [to be] absorbed and decline to the extent that other experiences and behavior can proceed without disruption” (Rachman<sup>11</sup>, p. 51). However, coping through EP, like all coping processes, is not universally adaptive, although patterns across empirical work on emotional approach coping<sup>12</sup> emotion regulation,<sup>13</sup> and repetitive thought processes<sup>14</sup> emerge.

When EP is constructive (e.g., planning, meaning making), coping strategies tend to be intentional, goal oriented, and facilitates dynamic problem solving and values clarification.<sup>15</sup> On the other hand, unconstructive forms of EP (e.g., rumination, worry, brooding) reflect a repetitive or prolonged focus on negatively valenced emotional material.<sup>14,16</sup> Coping through EP (and expression) has been associated with larger sAA and cortisol responses to experimental stress tasks,<sup>17</sup> bolstering the need to distinguish various forms of EP. Unconstructive forms of EP used in response to chronic stressors have been associated with a pronounced cortisol awakening response (AR), flattened diurnal cortisol slope, and increased SAM activation.<sup>18,19</sup> However, few studies

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have examined the use of constructive forms of EP and biological responding.

The present exploratory study examined how constructive and unconstructive processing, as measured from a cancer-related expressive writing task, are related to stress biomarkers in young adult male survivors. It was hypothesized that greater use of unconstructive processing would be associated with greater dysregulation in salivary biomarkers (flatter diurnal slope, greater daily volume, pronounced AR). No directional hypotheses were made for constructive processing.

## Methods

### Participants

Participants ( $n = 17$ ) were recruited from a parent study of quality of life in young adults with testicular cancer originally recruited from a state cancer registry. Those indicating interest in invitation to a subsequent study ( $n = 61$ ) were invited to take part in the current study through an invitation letter. Of the 61 who were contacted, 19 were unreachable. No known demographic differences characterized those that did and did not participate.

Eligibility included: men between the ages of 18 and 30, history of testicular cancer, and English proficiency. Men with severe psychiatric disorder or nonclearance by their physician were excluded. All participants received \$25 for participation and provided signed consent.

Participants (age: mean [ $M$ ] = 25.41,  $SD = 3.24$ ; range = 20–30) were primarily White (47.1%) or Hispanic (23.5%), and single (82.4%). The majority underwent surgery (94.1%), chemotherapy (52.9%), and/or radiation (41.2%). On average, they were 2.60 years ( $SD = 1.81$ ) since diagnosis.

### Procedures

Participants met with a study investigator to review study procedures and proper sampling methods. Participation included completion of an expressive writing essay and at-home collection of saliva on 3 consecutive weekdays at four points each day: upon waking (morning), 30 minutes after awakening, 8 hours after awakening, and at bedtime. They were instructed not to eat, drink, or brush teeth for at least 20 minutes before sampling. Each day, participants self-reported relevant health behaviors (e.g., caffeine intake, tobacco use) and compliance with collection instructions. Participants refrigerated samples until returning them through express mail. To complete the essay, participants wrote an expressive writing essay. Writing instructions were adapted from studies of expressive writing.<sup>20</sup> Instructions were to write continuously for 20 minutes without concern for grammar, spelling, or punctuation, and participants were instructed to write about their “very deepest thoughts and feelings” about their experience with testicular cancer. All procedures were approved by the university’s Institutional Review Board.

### Measures

Constructive/unconstructive processing. Constructive and unconstructive processing were measured through manualized coding procedures (see Hoyt et al.<sup>15</sup> for a detailed description). These procedures were developed to inform how one should process emotions toward maximal adaptive utility when coping with health-related adversity.<sup>15</sup>

Two trained coders independently coded each participant essay using line-by-line coding with one sentence as the smallest piece of text that could be coded, although multiple sentences could also be coded as a unified text unit. Consensus was reached within pairs.

Frequency counts of coded text units were summed for each of the constructive and unconstructive processing methods. Coded essays were given a global score for each constructive and unconstructive processing method based on the proportion of coded text units, which ranged from (1) *Not at all* to (5) *Extreme*. Constructive processing methods included planning/problem solving, values clarification/affirmation, goal-focused reflection, and discovery of meaning; unconstructive processing methods included worry, depressive rumination, anger rumination, and self-evaluative reflection. Frequency counts of constructive and unconstructive processing methods and illustrative quotations appear in Table 1. Following coding procedures, composite measures of constructive and unconstructive EP were computed by averaging scores. All scores were adjusted for overall essay word count. Composite measures were used in all analyses. High interrater reliability was obtained for constructive (85%) and unconstructive (99%) processing.

Salivary stress biomarkers. Daily diurnal salivary cortisol and salivary alpha amylase was assessed through saliva samples collected with Salivette collection tubes (Sarstedt, Inc.) at four points each day. Sample time collections were averaged across the 3 days for each sample time: waking: 7:42 a.m. ( $SD = 1.33$ ); 30 minutes postawakening: 8:13 a.m. ( $SD = 1.32$ ); 8 hours postawakening: 4:07 p.m. ( $SD = 1.54$ ); and bedtime: 11:51 p.m. ( $SD = 1.17$ ). Upon receipt, Salivettes were stored in a  $-20^{\circ}\text{C}$  freezer until analysis. Concentrations of salivary free cortisol and sAA were measured in duplicate using a commercially available enzyme immunoassay without modification to the manufacturer’s recommended protocol (Salimetrics, Carlsbad, CA).

### Data analysis

To account for skewness, raw values of both markers were log transformed before analyses. Three indices were calculated for each marker: AR, diurnal slope, and area under the curve (AUCg). AR was assessed by changes from awakening (averaged across days) to the second sample (30 minutes postawakening; averaged across days). Diurnal slope was calculated as the decrease from the first morning sample to evening sample. To assess volume, AUCg was computed and averaged across days using the trapezoidal method based on hours after waking.<sup>21</sup> The 30-minute postawakening measure was excluded from AUCg calculation.<sup>22</sup>

To determine the relationship of constructive and unconstructive EP and physiological responding, multiple linear regressions were tested. In each model, relevant covariates were entered in the first block and constructive or unconstructive processing in the second block. Covariates included participant age (in years), time since diagnosis (in months), and body mass index.

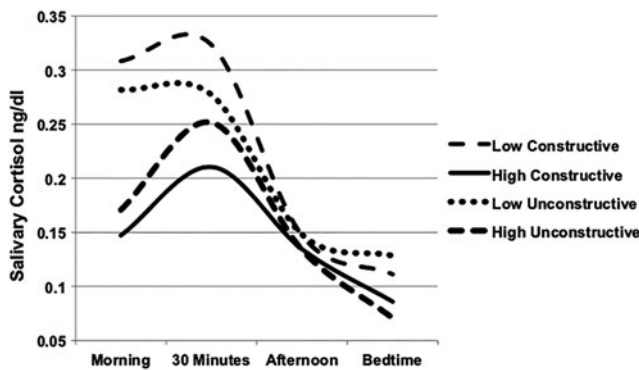
## Results

On average, young adult men were found to use constructive ( $M = 1.56$ ,  $SD = 0.39$ ) and unconstructive ( $M = 1.55$ ,

TABLE 1. CONSTRUCTIVE AND UNCONSTRUCTIVE PROCESSING

	<i>Average per essay frequency, mean (SD)</i>	<i>Total essays (%)</i>
Constructive processing		
Planning/problem solving: defining or appraising a problem, generating possible solutions, selecting alternatives, implementing solutions, or evaluating a plan. “I am still unsure if my surgery/chemo/radiation has left me sterile and unable to have kids and that is scary. I do want kids and so does my wife. It helps knowing I went to the sperm bank, but I’m hoping and praying that we won’t need to use what I froze” (30-year-old Caucasian male)	1.53 (0.94)	29.5
Values clarification/affirmation: thoughts related to declaring, clarifying, or affirming one’s values or beliefs. “As I’ve moved forward in my life, I still manage to come back to my cancer as a point of connection to others. I mention cancer and instead of creating a wall, it seems to almost instantly break down barriers in conversation. People want to know more, they want to know about my experience, and they want to know that I’m healthy in ways they never would have cared before. This makes the pain and trauma of the experience less and less every day, but keeps the event fresh in my mind so that I can continue to cherish the healthy time that I have and make the most of every day.” (29-year-old Caucasian male)	1.35 (0.61)	29.5
Goal-focused reflection: focused attention on one’s goals, including goal clarification and assessment of goal progress. “I think, as I said before, I mostly viewed cancer as something I needed to deal with to get on with my life. I was looking forward to graduating from law school, which I did a mere 8 weeks after I normally would have. I was (sort of) looking forward to the bar exam, which is nearly as bad as cancer. And I was looking forward to getting married, which I did on the one year anniversary of starting chemo.” (30-year-old Caucasian male)	1.24 (0.44)	23.5
Discovery of meaning: evidenced by a major shift in values, priorities, or perspectives in response to adversity. “After I was in remission, everything was great. I took advantage of my new life and went back to school. I changed jobs for the better and got in shape. I was feeling good enjoying life. I even started dating a girl I really liked” (26-year-old Hispanic male)	2.12 (0.86)	70.6
Unconstructive processing		
Worry: negative repetitive thoughts about potential threat, catastrophe, uncertainty, or risk. “I was starting to think about marriage ... I was stressing out a bit, but I realized I couldn’t do anything. I accepted it; that was when I started thinking about my past. If it was me, my actions, my experiences that lead me to this place in time, with her. Where I would have to make big choices. What would happen if this, was would happen if that, so many questions, that inheritably cancer came back into my thoughts.” (25-year-old Hispanic male)	1.82 (0.95)	52.9
Depressive rumination: thoughts marked by hopelessness, sadness, or worthlessness. “I’ve also stopped going to see my oncologist. It’s been over a year since, it got too depressing. I’ve been working on trying to move on from this ordeal, but it is sometimes overwhelming. I guess it just takes time” (25-year-old Caucasian male)	1.65 (1.06)	35.3
Anger rumination: repetitive or focused thoughts about angry or hostile experiences, revenge or retaliation fantasies, or dwellings on experienced/perceived injustice. “Shortly after, we all found out this ‘friend’ ... never even had a single brain tumor. He played all of us and disappeared. So I didn’t get the attention and support I deserved because somebody else decided to make up a life-threatening illness that he didn’t really have.” (20-year-old Caucasian male)	1.30 (0.77)	17.7
Self-evaluative reflection: statements reflecting an evaluation or assessment of one’s value, performance, skills, ability, knowledge, or attributes, including self-critical and self-judgmental thoughts. “Even though I laugh about it, there are times when I am very self-conscious about it. Sometimes, I feel like less of a man and even though I have a prosthetic, I feel physically deformed, which is hard to deal with at times” (28-year-old Caucasian male)	1.50 (0.80)	41.2

SD, standard deviation.



**FIG. 1.** Illustrates diurnal salivary cortisol patterns plotted at high (above the median) and low (below the median) levels of unconstructive and constructive processing. Raw cortisol values are plotted.

SD=0.43) methods equally in essay writing. The average essay length was 519 words (SD=279.26).

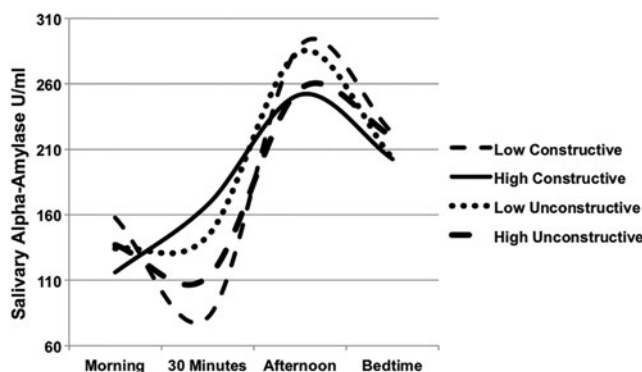
Salivary cortisol and sAA indices were separately regressed on constructive and unconstructive processing, controlling for identified covariates. Greater use of constructive processing was associated with lower overall daily cortisol output (i.e., AUCg) ( $\beta = -0.48$ ,  $p < 0.05$ ,  $R^2 = 0.33$ ). Constructive processing was also positively associated with sAA AR ( $\beta = 0.45$ ,  $p < 0.05$ ,  $R^2 = 0.48$ ). Constructive processing was not significantly related to other cortisol or sAA indices.

Unconstructive processing was significantly associated with overall daily sAA output (i.e., AUCg) ( $\beta = -0.52$ ,  $p < 0.05$ ,  $R^2 = 0.37$ ), such that greater use of unconstructive processing was related to lower daily sAA. Unconstructive processing was not significantly related to other cortisol or sAA indices.

Figures 1 and 2 illustrate cortisol and sAA, respectively, at relatively high and low levels of constructive and unconstructive processing.

## Discussion

This exploratory study offers initial insight into relationships of cancer-related EP styles and biological stress responses in young adult male cancer survivors. The associations of constructive processing use with lower overall cortisol output and altered sAA AR are noteworthy, and are in partial support of



**FIG. 2.** Illustrates diurnal salivary alpha-amylase patterns plotted at high (above the median) and low (below the median) levels of unconstructive and constructive processing. Raw alpha-amylase values are plotted.

hypotheses. Visual inspection of Figure 1 suggests that differences in cortisol output for low versus high use of constructive processing forms is greater in early times of the day, including upon awakening. If true, it may be reflecting differences in overall sleep disturbances or sleep quality, which have been shown to heighten HPA stress reactivity.<sup>23</sup> As sleep disturbances are commonly experienced among individuals with cancer,<sup>24</sup> future studies should examine these relationships in the context of sleep quality, as well as utilize momentary assessment methods to better determine the timing of effects. It will be useful to supplement the current study design with additional saliva collection points between awakening and afternoon.

Constructive processing was also negatively associated with altered sAA AR. This result is unexpected. Visual inspection of Figure 2 suggests that aberrant AR patterns are observed at high levels of constructive processing, a pattern observed in patients with significant distress or posttraumatic stress symptoms.<sup>25</sup> Future studies will need to more carefully test the possibility of a nonlinear relationship of constructive processing to stress. Importantly, the diurnal trajectories displayed in the figure are not categorical. That is, any individual could be high or low on constructive or unconstructive processing simultaneously. It might be that dysregulation associated with high constructive processing can be mitigated or worsened in the presence of unconstructive processing. Stressor-specific patterns should also be considered. That is, it is plausible that appraisals of one stressor (e.g., cancer-related financial strain) might yield cycles of worry, while the same person might engage in patterns of meaning making to process emotions related to infertility after testicular cancer. More adequately powered studies will need to test such potential interactions.

The experiencing and processing of cancer-related emotions are contextually bound. Stress and coping theory emphasizes the match between the stressor and coping method. Although participants freely wrote about any stressor, this study was not designed to examine the influence of the nature of the specific stressful content (e.g., interpersonal stressor vs. occupational demands). Future work should more carefully consider the valence of the emotional content. It may be that eustress, or other experiences of positive emotions, would distinguish biological stress patterns. Likewise, studies of coping by EP in cancer survivors have relied on measures ill equipped to distinguish among EP styles. Our findings suggest that future work examining the utility of coping with cancer-related stress through emotional approach should consider more careful measurement of EP.

Also in contrast with hypotheses, use of unconstructive processing was associated with lower overall daily cortisol output. It is, of course, plausible that use of unconstructive processing (e.g., avoidance) is successful in the short term. Worry for example, might serve as motivator, drawing attention toward situations that may require action, thus potentially facilitating more constructive processing efforts (i.e., goal-focused reflection).<sup>26</sup> Constructive processing methods on the other hand might be more effortful, intentional, and salient and therefore more arousing. Future research that examines these relationships longitudinally is needed to determine the time course of these relationships. Likewise, identification of the mechanisms by which constructive and unconstructive processing impact biology is needed. This will involve more careful consideration of the nature of the emotion-laden stressors (e.g., time limited vs. chronic, health-

related vs. interpersonal), the influence of stable personality factors (e.g., optimism, coping styles), as well as biobehavioral vulnerabilities (e.g., sleep quality, medication use).

This study, although preliminary, has several strengths, including being a useful first step in examining associations of EP forms and stress biomarkers in the context of young adult cancer adjustment. It also reaches beyond self-report measures and uses a novel approach to observe EP methods. However, it is not without limitations. The very small sample size warrants caution in interpreting results, which should be considered preliminary. Moreover, this study did not attempt to disentangle forms of processing with the presence of psychological distress (e.g., depression, anxiety), which can also signal biological responding.<sup>27</sup>

Despite these limitations, this study offers information to inform additional areas of inquiry. As psychosocial interventions move toward biobehavioral approaches, it is increasingly important to understand the manner in which intervention targets, such as coping through EP, impact stress-related biology.

#### Author Disclosure Statement

No competing financial interests exist.

#### Funding Information

Funding was provided by the Livestrong Foundation (PI: M.A.H.) and the National Cancer Institute (SC1CA187494, PI: M.A.H.; 1F99CA222727, PI: K.D.).

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